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Investigation on Electron Absorbed Dose in a Mixture of Natural Rubber Latex and Cross-linking Agents

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Natural rubber vulcanization using electron beam is one of interesting applications of electron linear accelerators with an energy in a range of a few hundred keV to a few MeV. At the Plasma and Beam Physics Research Facility, Chiang Mai University, a 4-MeV RF linear accelerator (linac) is developed for utilizing in natural rubber vulcanization. To accelerate the vulcanization process, cross-linking agents are added in a natural rubber latex to increase the bonding probability between the chains of the rubber molecules. Therefore, some properties e.g. molecular mass and density of the natural rubber latex are changed. This research uses Monte Carlo method in the program GEANT4 to simulate the electron absorbed dose in a mixture of natural rubber latex and cross-linking agents. The initial electron beam distributions are obtained from the beam dynamic simulation in the linac, which were done with the program ASTRA. The initial electron beams have mean energy in the range of 0.69 to 4.00 MeV at the position 6 cm prior the 50-μm titanium vacuum window foil. The air gap distance between the vacuum window to the natural rubber latex was set at 18 cm. The electron beam transportation in the titanium foil, air gap and a mixture of natural rubber latex were simulated. The cross-linking agents that are added in the natural rubber latex are ethylene glycol dimethacrylate (EDMA) and 1,6-hexanediol-diacrylate (HDDA). Finally, electron absorbed dose distributions in both transverse direction and along the depth of the natural rubber latex mixed with each cross-linking agent are calculated and analyzed. The results from this work can be used for experimental planning in order to irradiate the natural rubber latex with appropriate portion of cross-linking agents and electron absorbed dose.

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